Salt Alcohol Additive Pretreatment Improve the Performance of Heat Pump Dried Tilapia Fillets

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Tilapia, commonly known as African crucian, Nanyang crucian, has important edible value. Growing global tilapia production in recent years, China is the world's largest producer and exporter of Tilapia. In 2009, China's tilapia production was 1.257 million tons, and 47% of them from Guangdong Province.

processing method:
drying process and freezing process

Freezing process technology requires a large initial investment, higher costs of production and transportation.

Drying process: an important form
• two most commonly processing methods of drying fish: solar drying and air-drying

▲ long time consuming
▲ product shrinkage
▲ poor rehydration
▲ nutrition seriously damaged
▲ the energy consumption is relatively high

• Heat pump drying has a number of advantages
• energy-saving, the drying system in the closed state, easy to control humidity, wind speed conditions, and good drying quality
• This article used the heat pump drying process, adopted different drying additive to preprocessed tilapia fillets, and analyzed the pretreatment method that influenced tilapia heat pump drying process and products quality
Materials and Methods

*Materials and Reagents*

Tilapia: purchased in Xiashan seafood market, Zhanjiang city.  
Reagents (AR): Propylene glycol, Glycerin, NaCl.

*Instruments and Equipment*

Heat pump drying system (Lab self-built), UV spectrophotometer (Shimazu UV-1800), DZF-6050 series vacuum dryer, JA 2003A series electronic analytical balance, HD-4 intelligent water activity meter, HHS-electric constant temperature water bath

*Technological Process*

Preparing raw fish - Preparing fish fillets - Pretreatment - Heat pump drying - Equilibrium (10h) - Tests and analyses
Detection Method
1. Determination of Moisture Content
2. Determination of Water Activity
3. Measurement of Rehydration Ratios
4. Measurement of Ca2+-ATPase Activity

Results and Analysis
Effect of Pretreatment on Drying of Tilapia
The results indicated that there are many factors which impact the moisture content in tilapia fillets, such as hot air temperature, wind speed, thickness of fillet and fillets shape, and thickness of fillets which is the one that has the most effect, followed by the hot air temperature, wind speed (as shown in Figures 1-3)
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Fig.1 Heat pump drying curve of tilapia fillets treated with propylene glycol

Fig.2 Heat pump drying curve of tilapia fillets treated with glycerol

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Fig. 3 Heat pump drying curve of tilapia fillets treated with sodium chloride.
Figure 1, propylene glycol dipping pretreatment has a certain influence on the moisture content during drying process of Tilapia. At the beginning of drying process, propylene glycol accelerates the dehydration rate of fillets. As it is dried, this acceleration effect is less obvious. About 5 hours in the drying, moisture content of tilapia fillets dry basis which dipped propylene glycol is greater than the control group. Instead, moisture content of tilapia fillets that were dipped is greater than the control group after 12 hours of drying process. This may be because propylene glycol combined with moisture in the fish, thus hinders the moisture migration.

Figure 2, moisture content of tilapia fillets dipped glycerol decreased quickly in the early stage of the drying process, and went to stable region quickly, and then moisture content of dipped tilapia fillets was greater than the control group.

Figure 3, moisture content of tilapia fillets dipped NaCl decreased quickly because the NaCl osmotic dehydration effect on the fish. Moisture content decreased with increasing the addition of NaCl, but the difference is not obvious.
Effect of pretreatment on water activity levels of dry tilapia fillets

bacteria has the highest requirement for the water activity: Yeast requires Aw > 0.87
mildew start multiplying at Aw is 0.8
Meat: below 0.69
water activity value is above 0.8 in dry tilapia fillets without pretreatment, but water activity has declined in dry tilapia fillets with pretreatment before drying under the same drying conditions, and the activity value decreased with the increase of additive contents

Fig.4 Effect of different retreatments on water activity of tilapia fillets
Effect of pretreatment on rehydration ratio of dry tilapia fillets

the higher rehydration rate, the better dry tilapia fillets

rehydration ratio of dried tilapia fillets rinsed with dipping pretreatment of propylene glycol or glycerol on Tilapia fillets than the control group without pretreatment

Fig.5 Effect of different pretreatments on rehydration rate of tilapia fillets
Effect of pretreatment on Ca2+-ATPase activity of dry tilapia fillets

compare Ca2+-ATPase activity filter effectively pretreatment method to inhibit heat denaturation of fish protein the Ca2+-ATPase activity of dry tilapia fillets rinsed with pretreatment of dipping propylene glycol, glycerol or NaCl on tilapia fillets than the control group without pretreatment

the Ca2+-ATPase activity is the highest after dipping pretreatment by propylene glycol with the concentration of 3%, implying the heat denaturation level is minimal

Fig.6 Effect of different pretreatments on Ca2+-ATPase activity of tilapia fillets
RSM to optimize pretreatment process of heat pump drying tilapia fillets

Based on the RSM to optimize pretreatment process of heat pump drying tilapia fillets, took the additive contents of propylene glycol, glycerin, and NaCl as independent variable while the water activity and the Ca2+ -ATPase activity were taken as the response values, and designed response surface model to analyze the complex interaction between reagents and optimize pretreatment process.
The Box-Behnken experimental scheme of four factors at three different levels were used and the results of pretreatment shown in table 2.

### Table 2 The arrangement and result of RSM

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<th>$x_1$</th>
<th>$x_2$</th>
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<th>$Y_2$ (Water activity)</th>
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Results of calculated by the response surface model show that the optimal pretreatment process as follows: Propylene glycol 2%+ Glycerin 2.98%+NaCl 1%, then Ca2+-ATPase activity is 3.23μmol Pi/mgprot/hour and water activity is 6.73.

Practical analyses of the optimal pretreatment process as follows: Propylene glycol 2%+ Glycerin 3%+NaCl 1%, and the testability demonstration results: Ca2+-ATPase activity is 3.21μmol Pi/mgprot/hour and water activity is 6.75, obtained better results than that caused by single pretreatment factor.
Conclusion

1) Fish fillets dehydration result is better by using NaCl immersion than by using immersion of propylene glycol or glycerol. The sequence of the ability to reduce the water activity is NaCl > glycerol > propylene glycol.

2) The rehydration ratio of dry tilapia fillets rinsed with pretreatment of dipping propylene glycol or glycerol on Tilapia fillets, and the rehydration rate obtains its maximum values when additive contents are 5% and 3% respectively. However, NaCl performed differently in the rehydration rate of dry tilapia fillets. The Ca2+-ATPase activity of dry tilapia fillets rinsed with pretreatment of dipping propylene glycol, glycerol or NaCl on Tilapia fillets than the control group without pretreatment.
This indicates that the pretreatment of dipping propylene glycol, glycerol or NaCl on Tilapia fillets can effectively inhibit heat denaturation of fish protein in drying process. The Ca2+-ATPase activity is the highest after pretreatment by dipping propylene glycol with the concentration of 3%, implying the heat denaturation level is minimal.

3) With the water activity and the Ca2+ -ATPase activity as indices, calculated results by the response surface model show that the optimal pretreatment process parameters are: propylene glycol 2%+ Glycerin 3%+NaCl 1%. The optimal pretreatment process reduces the dried fish water activity 6% with the Ca2+ -ATPase activity decrease of 2%.
thank you!